33% of net added revenue that represents an *efficiency gain* is not only positive, but *greater than the allocative inefficiency cost.*

This allocative efficiency cost, the lower value of a license if won by a designated entity, can be expressed as P*V*D, where P is the probability that a designated entity wins, V the expected license value to a first-line bidder, and D (as before) the percentage by which the license value is lower for a designated entity.[13] Given a higher cost of capital, a small firm granted a sizable bidding credit can still only afford to submit a gross bid higher than that of a large firm if the small firm's use of spectrum will be at least nearly as efficient as the large firm's use.[14]

These findings were for sealed bidding, but they remain relevant to multi-stage progressive bidding. The reason that first-line bidders choose to bid more aggressively when designated entities are given bidding credits is simply that the first-line bidders want to lose to designated entities only rarely, and the bidding credits lead the designated entities to make higher gross bids. *It is precisely these higher gross bids that lead to higher revenue in multi-stage progressive bidding.*

The import of RHF's findings is that on the issue of bidding credits, two Congressionally mandated objectives, "... avoiding excessive concentration of licenses and ... disseminating license among a wide variety of applicants..." and "efficient and intensive use of the electromagnetic spectrum," are harmonious. In all likelihood, *attempting an efficient outcome requires the FCC to use bidding credits.*

16. The suggestion by US West and others that small firms' purpose in entering FCC auctions is pure speculation flies in the face of common sense, especially for the WCS auctions. The thousands of hours and tens, perhaps hundreds of thousands of dollars that must be spent to compete in the WCS auctions could easily be avoided, if one's purpose were to speculate on increased prices of spectrum in the future. The expedient way to speculate would simply be to make an equity investment in a small firm that wins some D, E, and F block licenses. Such firms will be looking for financing to cover buildout and

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[13]None of these three terms can be precisely known in the real world, but they can be specified in the model.

[14]As mentioned, the nature of the tradeoff varies with the probabilities; those interested in the particulars should contact the authors for details. At a very rough level, the most efficient subsidy level is often at or slightly above half of D, the percentage disadvantage. If efficiency were the sole consideration, only for strikingly low estimating errors would it pay to subsidize designated entities so sharply that they can participate on at least an even footing with first-line bidders. But even when the government has poor information about how extensive designated entities' disadvantage is, a somewhat cautious policy of granting bidding credits is preferable on efficiency grounds to granting no bidding credits at all.

operating costs. Moreover, it would be irrational to assume that this round of WCS auctions is to be the last round of broadband privatization.

Part II: Implications for WCS Rules

In this part, I outline the practical conclusions of an appropriate understanding of efficiency for the rules the FCC should adopt in WCS auctions.

17. Given that bidding credits used in part to fight warehousing are likely to increase WCS auction revenue, warehousing of spectrum is contrary to all four of the objectives Congress has mandated. Among envisionable uses of spectrum, warehousing is the least efficient and most anti-competitive. Naturally, then, fighting warehousing and resisting the lobbying of CMRS incumbents in implicit support of warehousing ought to be the FCC's highest priority.

18. Full capacity for a CMRS provider is by industry consensus somewhere far below 45 MHz. Accordingly, removing the 45 MHz cap can only serve to promote warehousing, and is contrary to all four Congressional objectives. Indeed, the FCC needs to consider seriously what it can do to keep firms from approaching the 45 MHz cap.

19. It makes sense to fight warehousing by placing CMRS incumbents at a disadvantage in the bidding in the particular MTAs where they hold spectrum. A simple and minimal way to do this would be to provide a 5% bidding credit on a particular license to any bidder who had no radio spectrum holdings at all in the geographic area covered by the license.

20. New and innovative uses of spectrum may prove to be economically viable at first only in particular regions of the country with the most favorable demographics for the planned uses. Moreover, at this stage, the firms attempting such innovative introductions may find it hard to raise the needed funding to compete for regional licenses. This suggests that licenses ought to be offered for as fine a partitioning of the U.S. as possible, to support such potentially innovative uses of spectrum. The FCC's stated constraint of 306 licenses is eminently reasonable given the time constraint, and the apparent impact of BTA-sized license areas in slowing down the C and the D, E, and F block auctions. Consistent with this constraint and the objectives would be selling three sets of paired 5-MHz channels in each MTA, 153 licenses in all.

21. A very small number of participants won a sizable fraction of all licenses in the A and B block auction, and again in the C block. Overall, the ratio of the number of firms winning at least one license to the number of licenses has been

small, and smaller for MTA auctions than for BTA. The FCC will only have to handle a relatively small number of wire transfers for down payments and for final payments if these 153 licenses are sold.

22. It is easy to underestimate the extent to which small firms are at a disadvantage. Assuming that the purpose of bidding is not to warehouse but to supply communications services, a bidder acquiring a license will face substantial investment in acquisition of capital equipment and of site usage permissions, and costs of equipment placement and testing. Before we know what the WCS licenses will cost, and what uses winners are planning, any estimates of the ratio of license cost to buildout cost must be so vague as to be near foolhardiness. Let us simply estimate that this ratio is 1-to-1.

Then for a firm to carry out its plans, it must come up with funds for upfront payments quickly, funds to cover the total cost of the licenses rather quickly, and funds to build out rapidly enough to get into the market and begin bringing in some revenue. As US West points out, the cost of the capital to do all this for a blue chip firm may be about 7%, and may be about 8% for a firm whose bond offerings will be rated investment grade, while a small firm may face an 18% cost of capital. These numbers change with financial market conditions, but their ratio changes rather little. Of course, due to compound interest, the ratio of the payments firms of different financial strength will have to make, to amortize debts of similar size over similar holding periods, substantially exacerbates differences in costs of capital.

23. In the C block auctions, net bids were 75% of gross bids for most bidders. However, under reasonable assumptions about Treasury interest rates and costs of capital, the present value of net bids (under payment plan C) was from 50% to 55% of net bids, which translates to 40-44% of gross bids. That is, the installment payment terms which presumably cannot be extended to small firms in WCS auctions were more valuable to their C-block recipients than were the bidding credits. So bidding credits that are no larger than 25% will ameliorate competitiveness disadvantages small firms face by less than half as much as the extent of assistance provided small firms in the C block auctions. While this does not make a compelling case for exactly the same standards, recall that the 40% bidding credits plus installment terms used in the Regional Narrowband auction have actually been shown to have put more money in the Treasury.

24. If the very nature of opening up auctions to bidders exploring new and innovative uses of spectrum, is that the bidders themselves have better information about how spectrum will be used in their planned applications,

than do other bidders or the FCC, then it stands to reason that maintaining flexibility ought to govern the type of licenses offered.

25. In particular, bidders seeking to develop communications services with low-tier microcellular technology, such as PACS, need paired channels, for which 5 MHz send and 5 MHz receive (for a total of 10 MHz per license) constitutes a technical requirement. A reason why more attention should be paid to these users than the typical applicant is the large gains in efficiency and competitiveness that could result from PACS or similar competition with a LEC. Also, pairing 5 MHz channels is a way to fight warehousing: if licenses were simply offered in unrelated 5 MHz groupings, a CMRS incumbent would be able to forestall a low-tier microcellular technology bidder, such as a PACS bidder, on 10 MHz while only incurring the cost of buying 5 MHz.

26. Similar to point 31, without knowing what technologies bidders select when being encouraged to introduce various technologies, any buildout requirement might be a requirement that we would choose not to impose on a particular technology. Specifying that there will be no buildout requirements is a way of accommodating them all.

27. With less usage of spectrum in rural than urban areas, there is no need for all rural areas to be served on all spectrum blocks.

Part III: Auction Form

I consider here the questions of whether the FCC should consider other auction forms for this WCS auction, and whether the FCC can be sure it can bring a multi-stage progressive auction to a timely conclusion.

28. It borders on the foolhardy to consider significant changes in the auction form given the time pressure. As this part indicates, the FCC can control auction speed so as to reach completion on time without opening up to significant inefficiencies. I do not consider license-specific bidding credits or a few permitted combinational bids significant changes in auction form, though they may be significant changes in the rules.

29. Alternatives are fraught with danger, or at least political embarrassment (which has definite economic consequences), and are rash given the circumstances. The simultaneous, multi-stage progressive auction was outlined in main detail by Paul Milgrom and Robert Wilson about 8 (narrowband) to 14 (broadband) months before its use, with activity rules described about 6 (narrowband) to 12 (broadband) months before use. Many details were widely debated in a relatively unhastened atmosphere. Moreover, the known alternatives to the proposed auction all had known, serious disadvantages.

Of course, it cannot be said that alternatives to an open outcry auction, or to continuous-time bidding all have known, serious disadvantages; the simultaneous, multi-stage progressive auction is an exception. Moreover, only a tiny fraction of the time for analysis is available, and at most a small subset of the auction theorists engaged for analysis then will be engaged now. Also, there is no clear analysis that implies an open outcry auction, or continuous-time bidding with discrete pauses, actually promises to bring the auction efficiently to a speedier conclusion. Much of the time needed to run the auction under current rules, under the simultaneous, multi-stage progressive form, is time that is needed either to provide bidders feedback about prices, or to allow the bidders to use that information to revalue licenses and strategies. Which of these purposes do supporters of an alternative think are so unimportant that time ought not be allowed for that purpose?

30. The number of licenses, bidders, and rounds are likely to be less than the D, E, and F block auction. I am not worried about finishing on time: The FCC has three rather efficient weapons to hasten conclusion without raising significant inefficiency concerns. The first is to increase the number of rounds per day, boldly and inexorably. The FCC has heretofore given in all too readily to objections to more rounds per day, as if not noticing the poverty of the arguments objectors raise. Too little attention has been given to how well this strategy worked in the National Narrowband auctions.

I argue the following schedule is without logically compelling defects:

On day:	At round:	Begin this number of rounds per day:
4	4	2
9	14	3
12	23	4
15	35	5
18	50	6
23	80	7
28	115	8
38	195	10

where only business days are counted. This schedule fits 100 rounds into 5 weeks, 178 into 7 weeks (not counting holidays). This schedule may look egregious to some, but notice that it can be relaxed some and still fit within the FCC's time line. (Whatever actual schedule the FCC puts out may be more widely accepted if compared with this proposal.) Also realize that the lower parts of the schedule are not expected to be reached; the auction should be over before then.

Complaints to any sensible schedule can safely be predicted, but they will largely be emotional and unresponsive to the Congressionally mandated revenue deposit deadline. The key to the schedule's success is to use its relentlessness to induce bidders to simplify their goals and strategies, and promptly indicate their willingness to outbid rivals for those licenses which are key to them. A haphazard schedule of increases in rounds per day, soliciting comments every time the FCC tentatively proposes more rounds, has all the wrong incentives. Indeed, it is critical that the FCC announce the schedule at least three steps at a time, as in "We shall proceed to 4 rounds per day at round 23, 5 rounds per day at round 35, and 6 rounds per day at round 50." The FCC must mean it: any objections raised that are deemed worth paying attention to can affect when the FCC goes to 7 rounds per day, but not to the decision already announced.

Similarly, the details of the associated daily schedule should be announced three steps in advance, and should appear unrelenting, both shortening bid submission periods and bid withdrawal periods (with few new bids expected, submission periods can eventually be cut to 15 minutes or considerably less, withdrawal periods to 5 minutes), and unrelentingly increasing the length of the auction day as well.[15] Sleep deprivation can work wonders.

31. The second weapon is minimum bid increments, which were quite effective in the Regional Narrowband auction, even more effective in the National Narrowband auction, and have been set less and less effectively as the Broadband auctions have proceeded. Minimum opening bids need to return, perhaps at $0.01 per MHz-pop (even slightly higher, perhaps). If some licenses had gone rounds with no bids at all, the minimum opening bid could be reduced; however, such reductions should appear so infrequent and random that a bidder has no reason to delay tendering an initial bid hoping for a further minimum bid reduction.

The serious problem in the D, E and F block auction, though, has been with how low bid increments have been when the initial bid on a license was trivial and there was further activity in that BTA. It is critical to keep huge minimum bid increments on licenses with extremely low prices, 100% or even 400%, at least until stage transition decisions appear. Automobile auctioneers have long known that bid increments at the end of an auction limit inefficiencies and lost revenue, and may need to be small, but that a larger bid increment earlier in an auction, if it can be used, brings the price into line much faster without creating significant chances for large inefficiencies. Indeed, on

[15]This works best if every time rounds are added, West Coast bidders can see their day starting earlier and East Coast bidders can see their day ending later.

any license with 3 or more new bids, a 40% bid increment can be used for at least the following round, quickly decreased thereafter if it prevented all new bids on that license.

32. The third weapon is a new system for ending the auction without the nearly unlimited inefficiencies introduced by announcing a final round that effectively converts to a first-price auction.

Suppose the FCC decides before round T that they wish to bring the auction to an orderly end. The following twelve-round ending procedure would be invoked. That it might be invoked, and how it would work if invoked, would be announced to the bidders before the auction began. It involves the following steps:

A. The FCC announces before round T begins that round T will be the *last* opportunity for bidders to submit a bid which *exceeds* the minimum bid on a license. If the FCC has not already done so, it announces a very large number of rounds per day (say, 10), justified by the fact that bids in later rounds for any license, do not involve a decision of how much to bid, but merely whether to bid. Bidders are reminded that ties (which will now become more numerous) will continue to be broken by time of bid receipt.

B. At the same time, the FCC announces that it will be closing markets with three consecutive rounds of no new bids, first doing this in round T+4, and every round thereafter. (Simultaneous closing has some efficiency advantages, but at some point they must be sacrificed if auction completion is critical. The potential inefficiencies associated with this closing rule are quite small compared to a single final round.)

C. Before round T+2, the FCC announces two rule changes that will take affect beginning with round T+6. First, any bidder will have a new option for any license for which it is the standing high bidder, called a Contingent Raise. The effect of a Contingent Raise will be to enter a bid by that bidder at the minimum bid if any other bidder submits a legal bid for the license, otherwise to leave the current high bid standing. The bid entered on the bidder's behalf, if used, will be regarded as received at the same time the FCC receives the Contingent Bid instruction, and thus will have the same standing for tie-breaking. Second, a bidder with a standing high bid in a market no longer gets to count that bid for eligibility calculations; only new bids and Contingent Bids preserve eligibility.

D. During these rounds, a sizable bid increment is used in any market with 3 bids, and an even larger bid increment in markets with 4 or more bids.

E. The FCC announces at least 6 rounds in advance that round F will be the final round. Round F is at least 12 rounds after round T, when this process was

invoked. Note that in round F, a standing high bidder on a license submits either no bid or a Contingent Bid; any other bidder submits either no bid, or a bid at the minimum bid increment. Minimum bid increments are set lower than in the previous round. The tie-breaking rule determines the final winners on any license drawing more than a single bid.

The notion behind the Procedure is that ultimately demand is most simply reduced to supply by imitating a Walrasian auctioneer. If demand cannot be fully reduced rapidly enough, rationing is used (via tie-breaking). Since opportunities to bid as much as bidders wanted have not succeeded in removing excess demand, such opportunities will be given only once more. The Procedure works best if the FCC sets fairly high bid increments during all rounds after T but before F, relying on rationing as little as possible. The remaining inefficiencies associated with round F tie-breaking are likely minimal, but the most important aspects of the Procedure are [i] it ends, within little more than a day, [ii] it deliberately chooses to sacrifice the revenue that a final first-price round might achieve to prevent the inefficiencies such a round would entail, and [iii] it ends.

Part IV: Time Pressure

Finally, I point out why the most critical time constraint is the need to give bidders time after rules are set to get their financial resources in place.

33. It is critical to have a significant time after rules are finalized before upfront payments are due; I call this time frame the "business-planning" period. There can be little doubt that a significant portion of the difference between C block and D, E, and F block prices is due to the astonishing FCC decision to require upfront payments for the latter auction only 7 weeks after announcing rules that doubled downpayments and quadrupled upfront payments. (That rash action makes one queasy about how the FCC will respond to explicit Congressional time pressure. It is as if the care that went into conducting Narrowband, A/B, and C auctions were deemed no longer important.)

Haste, in terms of too little business-planning time, creates difficulties not solely in lost revenue—fairness and efficiency suffer as well. That is, particular potential bidders are the ones effectively shut out of the bidding by such rash decisions. Those shut out are disproportionately firms seeking to obtain outside backers, most especially those who seek to convince outside backers to support plans to obtain funding for new and different technologies. Any firm seeking outside support must re-prepare its business plan after rules changes such as those announced for the D, E, and F block, and begin afresh its pitch to potential backers. The less mainstream the business plan, the more details that

must be re-worked, and the more time backers must have if they are to decide sensibly.

That FCC decision to allow only 7 weeks for business-planning, in my opinion, amounted to an unambiguous violation of clearly stated Congressional instructions to include small businesses and new technologies. The FCC was instructed to provide diversity in licensing and avoid excessive concentration in licenses, which is hardly possible if small businesses are barred from competing. The tight Congressional time schedule should be viewed as reinforcing those instructions. Repeating a business-planning time frame under 90-100 days would amount to twice deciding to bar these firms. Should the firms twice barred then seek an injunction, they may well find Congressmen willing to offer *amicus curiae* support.

34. Of course, the FCC has no need for such a short business-planning period to stay within the Congressional time frame. For one thing, its wholly appropriate plan to allow only wire transfers for payments means round 1 can begin on the afternoon of the third business day after the upfront payments deadline, and winners' wire payments can be processed much more quickly as well. Secondly, it is completely sensible to make April 15 the short-form submission deadline, April 29 the upfront payments deadline, begin round 1 on May 2, and declare that the Congressional deadline for starting the auction has been met.

Appendix I

This Appendix provides calculations supporting the claim that a firm using low-tier microcellular technology, such as PACS, entering a local exchange market has a far greater impact on market concentration than either [i] a new entrant into cellular/PCS competition, or [ii] enhancing the capacity of current players in the cellular/PCS market.

Consider a market with 1,000,000 subscribers, for convenience of calculations. Consider *Scenario A*: the LEC's only competition is 3 one-stop shopping firms, to whom it resells local connections. Let the three resellers have 35,000, 30,000, and 25,000 subscribers; suppose 20% of each reseller's customers have wireless service. Then the Herfindahl-Hirschman Index (HHI), based solely on subscribers, is:

Firm	Market Share	HHI
LEC	91.00	8,281.00
Rslr 1	3.50	12.25
Rslr 2	3.00	9.00
Rslr 3	2.50	6.25
Subscribers-Based HHI:	100.00	8,308.50

However, this calculation ignores the fact that the LEC has nonnegligible control over the resellers' costs, and hence their prices. An HHI based upon receipt of access charges would show:

Firm	Market Share	HHI
LEC	98.20	9,643.24
Rslr 1	0.70	0.49
Rslr 2	0.60	0.36
Rslr 3	0.50	0.25
Access-Based HHI:	100.00	9,644.34

Clearly both subscriber-based and access-based measures provide useful information. To combine them, I simply use the average: the combined HHI for Scenario A is 8,642.46.

Scenario B: A firm using low-tier microcellular technology (called PACS entrant below), enters and competes with the LEC and the three resellers. Let the PACS entrant be conservatively assumed to obtain 4% of the customers of each reseller, and 9% of the customers of the LEC; an argument why this is a reasonably conservative assumption follows the calculations. Continue to assume that 20% of each reseller's customers have wireless service.

Firm	Market Share	HHI
LEC	82.81	6,857.50
PACS	8.55	73.10
Rslr 1	3.36	11.29
Rslr 2	2.88	8.29
Rslr 3	2.40	5.76
Subscribers-Based HHI:	100.00	6,955.94

Next, suppose that the access charge the PACS pays to the LEC each time a PACS-originated call terminates at an LEC connection is equal to the access charge the LEC pays to the PACS each time an LEC-originated call terminates at a PACS connection. Also suppose that call originations and call terminations have uncorrelated distributions. Then an HHI based upon receipt of access charges would show:

Firm	Market Share	HHI
LEC	89.72	8,050.04
PACS	8.55	73.10
Rslr 1	0.67	0.45
Rslr 2	0.58	0.33
Rslr 3	0.48	0.23
Access-Based HHI:	100.00	8,124.15

The combined HHI is now 7,248.00, a substantial reduction in market concentration. Yet scenario B is a conservative estimate of the gains from PACS entry into a local exchange market.

Scenarios C-G consider potential impacts of WCS licenses being used for entry (low- or high-tier) or added capacity in CMRS markets, using the sort of capacity-based HHI calculations the FCC used to support maintaining the 45 MHz spectrum cap for the D, E, and F block auctions. Each scenario is presented with two sets of capacity numbers. The first set comes from the capacity situation in New York, the second from Los Angeles, both after the D, E, and F block licenses are awarded.

Scenario C1, before the WCS auction:

Firm	**MHz**	**Market Share**	**HHI**
Cellular A	35	20.59	423.88
Cellular B	25	14.71	216.26
PCS A	40	23.53	553.63
PCS B	30	17.65	311.42
PCS C	30	17.65	311.42
Big SMR	10	5.88	34.60
Total	170	100.00	1,851.21

*Scenario D*1, which adds a single-license WCS holder:

Firm	MHz	Market Share	HHI
Cellular A	35	19.44	378.09
Cellular B	25	13.89	192.90
PCS A	40	22.22	493.83
PCS B	30	16.67	277.78
PCS C	30	16.67	277.78
WCS	10	5.56	30.86
Big SMR	10	5.56	30.86
Total	180	100.00	1,682.10

*Scenario E*1 instead assumes that WCS licenses go to the largest capacity holders in the market, subject to the 45 MHz spectrum cap:

Firm	MHz	Market Share	HHI
Cellular A	45	22.50	506.25
Cellular B	35	17.50	306.25
PCS A	40	20.00	400.00
PCS B	40	20.00	400.00
PCS C	30	15.00	225.00
Big SMR	10	5.00	25.00
Total	200	100.00	1,862.50

*Scenario F*1 has WCS licenses going to lower capacity holders in the market, subject to the 45 MHz spectrum cap:

Firm	MHz	Market Share	HHI
Cellular A	35	17.50	306.25
Cellular B	35	17.50	306.25
PCS A	40	20.00	400.00
PCS B	40	20.00	400.00
PCS C	40	20.00	400.00
Big SMR	10	5.00	25.00
Total	200	100.00	1,837.50

*Scenario G*1 assumes that WCS licenses go to some of the largest capacity holders in the market, and assumes the 45 MHz spectrum cap is removed:

Firm	MHz	Market Share	HHI
Cellular A	45	22.50	506.25
Cellular B	25	12.50	156.25
PCS A	50	25.00	625.00
PCS B	40	20.00	400.00
PCS C	30	15.00	225.00
Big SMR	10	5.00	25.00
Total	200	100.00	1,937.50

Next we repeat the same scenarios, but base the capacities on the initially less concentrated market in Los Angeles. *Scenario C2*, before the WCS auction:

Firm	MHz	Market Share	HHI
Cellular A	35	19.44	378.09
Cellular B	25	13.89	192.90
PCS A	30	16.67	277.78
PCS B	30	16.67	277.78
PCS C	30	16.67	277.78
PCS D	20	11.11	123.46
Big SMR	10	5.56	30.86
Total	180	100.00	1,558.64

Scenario D2, which adds a single-license WCS holder:

Firm	MHz	Market Share	HHI
Cellular A	35	18.42	339.34
Cellular B	25	13.16	173.13
PCS A	30	15.79	249.31
PCS B	30	15.79	249.31
PCS C	30	15.79	249.31
PCS D	20	10.53	110.80
WCS	10	5.26	27.70
Big SMR	10	5.26	27.70
Total	190	100.00	1,426.59

Scenario E2, WCS licenses go to the largest capacity holders in the market, subject to the 45 MHz spectrum cap:

Firm	MHz	Market Share	HHI
Cellular A	45	21.43	459.18
Cellular B	35	16.67	277.78
PCS A	40	19.05	362.81
PCS B	30	14.29	204.08
PCS C	30	14.29	204.08
PCS D	20	9.52	90.70
Big SMR	10	4.76	22.68
Total	210	100.00	1,621.32

Scenario F2, WCS licenses going to lower capacity holders in the market, subject to the 45 MHz spectrum cap:

Firm	MHz	Market Share	HHI
Cellular A	35	16.67	277.78
Cellular B	35	16.67	277.78
PCS A	40	19.05	362.81
PCS B	30	14.29	204.08
PCS C	30	14.29	204.08
PCS D	30	14.29	204.08
Big SMR	10	4.76	22.68
Total	210	100.00	1,553.29

Scenario G2, WCS licenses go to some of the largest capacity holders in the market, and the 45 MHz spectrum cap is removed:

Firm	MHz	Market Share	HHI
Cellular A	50	23.81	566.89
Cellular B	25	11.90	141.72
PCS A	45	21.43	459.18
PCS B	30	14.29	204.08
PCS C	30	14.29	204.08
PCS D	20	9.52	90.70
Big SMR	10	4.76	22.68
Total	210	100.00	1,689.34

Finally, the HHIs calculated are combined in the last table. To evaluate these changes in the HHI, some social welfare measure is needed which incorporates the notion that a reduction in market concentration is more important in a more concentrated market (that is, for example, reducing the HHI from 6,000 to 5,000 is a more important impact than reducing from 3,000 to 2,000). Here I have used the formula SWG = [HHI1]^1.5 - [HHI2]^1.5 to produce the approximations shown in the Social Welfare Gain column. This column does not reflect another aspect that ought to be considered, the size of the market. Presumably a given reduction in the HHI is more important in a larger market.

Impact of WCS:	Changes HHI: From:	To:	Social Welfare Gain:
PACS entrant faces LEC:	8,976.42	7,540.05	1,957.33
NY Scenarios:			
WCS entrant in CMRS:	1,851.21	1,682.10	106.61
Add capacity, w/cap, bad:	1,851.21	1,862.50	-7.30
Add capacity, w/cap, better:	1,851.21	1,837.50	8.83
Add capacity, remove cap:	1,851.21	1,937.50	-56.33
LA Scenarios:			
WCS entrant in CMRS:	1,558.64	1,426.59	76.52
Add capacity, w/cap, bad:	1,558.64	1,621.32	-37.49
Add capacity, w/cap, better:	1,558.64	1,553.29	3.17
Add capacity, remove cap:	1,558.64	1,689.34	-79.00

In conclusion, entry of a low-tier microcellular competitor in a local exchange market has market concentration benefits that are about 18 times as important as the benefits of a WCS entrant into a CMRS market (as concentrated as New York) of the same market size, or about 90 times as important if the local exchange market is 5 times as large as the CMRS market. In a less concentrated market like Los Angeles, LEC competition is over 25 times as important, 125 times given differential market size. All the other scenarios fare even worse; even when capacity is added to less large firms (scenario F), the impact is a tiny fraction (1/200 to 1/3,000) of the gain via competing with a LEC.

Auction policies which foster opportunities for a low-tier microcellular provider, such as a PACS provider, to compete with a LEC have huge pro-competitive advantages, likely outweighing arguments for alternative policies.

ATTACHMENT 4

Is Subsidizing Inefficient Bidders Actually Costly?

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Abstract

A widespread practice, particularly in public-sector procurement and dispersal, is to subsidize a class of competitors believed to be at an economic disadvantage. Arguments for such policies vary, but typically assume that benefits of subsidization must be large enough to outweigh a presumed economic cost of the subsidy. When the disadvantaged competitors compete with first-line bidders in an auction, the subsidy serves to make them more competitive rivals. First-line bidders rationally respond by bidding more aggressively. We consider a restrictive but realistic and useful model of procurement auctions, and show that a policy of subsidizing inefficient competitors can both lower expected project cost and enhance economic efficiency. Indeed, some subsidy is generally better on both cost and efficiency grounds than no subsidy, even when the government's estimates of the extent of the subsidized bidders' cost disadvantage and of the degree of common cost uncertainty are way off the mark. In a simple dynamic model, subsidizing inefficient competitors can incur the disadvantage of enhancing the entry of inefficient firms, yet for a wide range of parameters, the short-run benefits of increasing competition overcome this disadvantage.

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1. Introduction

From time to time, certain classes of competitors are given explicit advantages in competitions, such as auctions. Favored classes have included veterans, racial minorities, women, and small businesses.[1] Often, the classes accorded advantages are considered, at least on average, to be disadvantaged (i.e., less effective competitors). The rationale for the advantage frequently stems from important noneconomic aspects—gratitude and compensation for veterans' past service, compensation for past discrimination against minorities and women, populist concerns for small businesses, and, in general, notions of fairness.

Sometimes, a class of competitors is favored via quotas or set-asides. However, often the advantage takes the form of subsidies, discounts, credits, or special payment terms should a disadvantaged competitor win.[2] Such special payment or compensation terms are analyzed in this paper, in an auction setting.

While the rationale for such special treatment is often based upon hotly debated considerations of fairness, it is widely presumed that such favoritism is costly for the bidtaker, and economically inefficient.[3] We argue that neither presumption is necessarily correct.

Consider sealed bidding for a construction project. Suppose that there are several bidders and that, while the cost of the job is uncertain, it is clear to all concerned that it will cost one of the bidders (the "designated" bidder) about 20% more than it would the others to do the job. Should the bidtaker offer publicly to subsidize the designated bidder, for example by offering to pay him 15% more than the amount of his bid, if he wins the job? In this paper, we set aside redistributive or other political reasons for subsidy policies, to focus on purely economic considerations: the bidtaker's expected project cost may well be reduced by offering such a subsidy. Furthermore, suppose the bidtaker is a government body that must raise revenue via distortive taxes; then the economic efficiency impact of the reduction in expected project cost may well

[1] Veterans have been given explicit advantages on civil service examinations. In some of the US Federal Communications Commission's auctions of radio spectrum rights, as discussed below, preferred status has been given to firms owned by minorities or women, "small" businesses, and rural telephone companies.

[2] In the spectrum auctions, favored bidders were given both direct price discounts and partial financing of the bulk of payments at favorable interest rates, cf. Federal Communications Commission [1996].

[3] "Civil rights advocates have implicitly conceded that affirmative action subsidies burden the public fisc—they argue instead that the social benefits of remedying past discrimination or of promoting diversity justify the cost of the government subsidies." Ayres and Cramton [1996], p. 450.

outweigh the allocative inefficiency caused by the increased chance that the designated bidder will win the job. Thus, surprisingly, in these circumstances, economic efficiency requires the government bidtaker to subsidize the inefficient competitor.

In order to analyze such situations, it is necessary to deal with asymmetric auctions. In general, it has proven difficult to find Nash equilibria when asymmetric bidders face related cost uncertainties, as when contractors face uncertain weather delays or future materials prices.[4] However, Rothkopf [1969] developed a model in which bidders are restricted to bidding a multiple of their cost estimate (rather than an arbitrary function of it), yielding a closed-form solution for equilibrium strategies in two-bidder asymmetric auctions. It is also relatively simple to find equilibrium strategies numerically in his model with more than two bidders. This paper uses that model to explore the effects of subsidizing designated bidders. The insights this exploration generates may, we believe, be relevant to the current debate about policies favoring designated competitors in procurement and in licensing.[5]

Ayres and Cramton [1996] argue that the usual accounting for the costs of subsidizing disadvantaged competitors overestimates by orders of magnitude, through neglect of the impact subsidies have on the bidding of competitors who are not subsidized. They claim that a subsidy policy can sometimes materially benefit the bidtaker. This work lays the theoretical foundation for that claim, and is thus complementary to Ayres and Cramton, who provide a clean empirical argument that the Federal Communications Commission actually raised greater revenue in the "Regional Narrowband" auction of radio spectrum rights in 1994 by subsidizing minority-owned firms than would have resulted without the subsidies. Their paper argues for the wide applicability of the logic

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[4]Asymmetric equilibria have been found for some private-values auction models (and do not exist for some particular symmetric models, cf. Maskin and Riley [1992]). The dominant strategy in second-price, private-values auctions does not depend on symmetry. Marshall et al. [1994] calculate numerically the independent-private-values first-price equilibrium for the example of uniformly distributed types, either two bidders or one bidder facing a cartel; Waehrer [1994], Maskin and Riley [1993] and Lebrun [199x] have some qualitative characterizations of independent-private-values first-price equilibria.

McAfee and McMillan [1989] address questions that overlap ours, primarily being concerned with whether a government should subsidize domestic bidders when they compete with foreign firms to supply the government. They seek to maximize a welfare function that treats a payment to foreign firms as a cost, but to domestic firms as a transfer. The principal limitation of their results is dependence upon the private-values assumption: in their model there is private information, but no cost uncertainties or statistical dependencies of costs. We would hesitate to use such a model for any policy applications.

[5] It is from that debate (cf. The US Federal Communications Commission, Public Docket No. 93-253) that we have borrowed the phrase "designated bidder."

that tilting competitions to favor disadvantaged participants yields the real benefits of advantaged participants competing more aggressively.

The next section outlines the Rothkopf [1969] model and relevant results, and discusses the import of the multiplicative strategies restriction. After that, the paper uses the 1969 model to identify when it is advantageous to a bidtaker to subsidize designated competitors and when it is economically efficient to do so. It starts with two-bidder situations, and then examines more general cases. In many markets, subsidizing inefficient bidders might have the undesirable long-run consequence of making it relatively more profitable to be inefficient, and thus encouraging entry of inefficient firms; section 5 considers these possibilities in a simple model of entry incentives, and suggests that it may take very strong specifications of impacts of subsidies on entry to overturn the short-run benefits from subsidizing. The bidtaker often may lack the information necessary to set an optimal subsidy rate; our suggestion in section 6 is that cautious setting of a subsidy is still preferable to foregoing the added competition it engenders. A final section draws some conclusions.

2. The Multiplicative-Strategy Model

Asymmetry is inherent in any model of disadvantaged bidders. Game-theoretic modeling of asymmetry in auctions in general has proven difficult. However, there has long been available a class of game-theoretic models that can be solved for asymmetric situations--multiplicative strategy models (Rothkopf [1969, 1980a]). These models restrict bidders to bidding multiples of their estimates of value or cost rather than arbitrary functions of the estimates. Thus, a bidder who is using a strategy of bidding 120% of her cost estimate, will use that multiplier whether her cost estimator gives her an estimate of $1,000,000 or $10,000,000. Such strategies are often reasonably realistic from a behavioral point of view.[6] They are never precisely optimal in the context of general strategies, but they are asymptotically optimal as the amount of prior common information relative to the amount of information contained in the private estimates becomes small (Rothkopf [1980a, 1980b]).[7]

The symmetric version of the model we use is a common value model. In it, each bidder knows that her cost or value is identical to that of every other

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[6] See for example the analysis in Capen, Clapp and Campbell [1971], the paper that introduced the "winner's curse" notion to the academic literature.

[7] It is our suspicion that frequently this assumption is less significant to qualitative characterizations than other common assumptions, like the independent private values assumption (which we do not make) or the assumption that bidders have no private information about competitors' estimates (which we assume here, like all auction theory antecedents; we discuss its impact in Harstad, Rothkopf and Waehrer [1996]).

bidder. The difficulty is that the cost or value is unknown. Each bidder draws an independent private sample from the same unbiased cost or value estimating distribution. All bidders know that this is the process and know the particular distribution. The asymmetric version differs only in that the bidders' common knowledge about the relative true costs or values of the bidders is now a ratio different from one. Thus, for example, it is common knowledge that a bidder with a 10% cost disadvantage relative to that of another bidder will draw her cost estimate from an unbiased distribution that is 10% higher at every probability level.

In order to obtain analytic solutions, Rothkopf's multiplicative strategy model uses distributions from extreme-value statistics. For auctions in which bidders are competing to supply, the assumption is that the estimates are drawn from a Weibull distribution. This distribution has cumulative function

$$F(x) = 1 - \exp(-ax^m), \quad x > 0,$$

and density

$$f(x) = a\, m\, x^{m-1} \exp(-ax^m), \quad x > 0.$$

In this distribution, the spread parameter m controls u, which is the standard-deviation-to-mean ratio. As m goes from 1 to 10 to 100 to infinity, u goes smoothly from 1 to 0.12 to 0.0127 to 0. Higher u's correspond to greater bidder uncertainty about project cost. For auctions in which bidders are competing to purchase, the distribution is Gumble's third asymptotic distribution which is the distribution of the reciprocal of a Weibull-distributed random variable. It has cumulative

$$F(x) = \exp(-ax^{-m}), \quad x > 0,$$

and density

$$f(x) = a\, m\, x^{-m-1} \exp(-ax^{-m}), \quad x > 0.$$[8]

[8] For more details on this distribution, see Gumble [1958].

For the symmetric model in which n bidders are competing to supply, the equilibrium multiplicative strategy is

$$P^* = m\,(n-1)\,n^{1/m} \,/\, [m\,(n-1)-1],$$

and the expected value of the equilibrium winning bid is

$$x_{\min} = c + c \,/\, [m\,(n-1)-1],$$

where c is the true but unknown common cost of the job.

When there are two bidders, indexed 1 and 2, with unknown true costs known to be in the ratio

$$S = c_1 / c_2,$$

the equilibrium strategies are

$$P_1^* = m\,(1 + 1/Y)^{1/m} \,/\, (m - Y),$$

and

$$P_2^* = m\,Y(1 + 1/Y)^{1/m} \,/\, (m\,Y - 1),$$

where Y is defined by

$$Y = \{m\,(1-S) + [\,m^2\,(1-S)^2 + 4\,S\,]^{1/2}\} \,/\, 2.$$

With these equilibrium strategies, the probability of bidder 1 being the low bidder is

$$p_1 = 1 - 1 \,/\, (Y + 1),$$

and the expected payment by the bid taker is